Topology Optimized Building Blocks for Integrated Photonics

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In recent work we have extended and applied the topology optimization method [1] to the synthesis of various building blocks potentially to be used in integrated photonic circuits. The topology optimization method essentially consists in repeated field solutions (finite element analyses of the field equations) and material redistribution steps (free redistribution of dielectric). Typically a few hundred analyses are required for convergence to the optimized solution. So far, we have presented topology optimized solutions for various bends (120, 90 and 60 degrees) which have been experimentally verified to have hitherto unprecedented bandwidths and transmissions. Both TE and TM-polarization bends and splitters have been demonstrated [2-5].

In this paper, we discuss the topology optimization method in more details, we discuss its strengths and weaknesses, and we demonstrate new applications in couplers, tapers, de-multiplexors and others. The method is equally efficient for the synthesis of band gap as for photonic wire based waveguides and we compare the different design formulations for transmission and bandwidth.

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